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ENVIRONMENTAL PROBLEMS IN THE PRODUCTION OF HOUSEHOLD AND CRYSTAL GLASS

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Data on studying atmospheric emissions and pollution of the working space by lead compounds in the production of glass and crystal glass articles are given. Various logistic and engineering measures that make it possible to reduce toxic emissions and improve the ambient medium are considered.

In 1998 – 1999, the Russian Federation passed the very important laws "On protection of atmospheric air" and "On industrial wastes", which state the main principles regarding environmental policy and management. This legislation concentrates on human health care, maintenance or restoration of favorable environmental conditions, and conservation of natural resources.

The production of household and crystal glass involves the use of natural resources and has a negative effect on the environment. In the production of household glass, it is necessary to adhere to the main hygienic and environmental regulations, whose goal is to decrease atmospheric pollutant emissions and discharge of contaminants into natural waters and to utilize or appropriately store industrial waste. An important requirement is to ensure safe working conditions.

Every company, depending on its polluting emissions and processing of materials classified as certain grades of danger, is classified in a danger category from 1 to 4. Since household-glass production is related to the use and emission of pollutants of danger grades 1 – 2 (lead, fluorine, arsenic, and selenium compounds), glass factories are classified in danger grades 2 – 3. According to the current hygienic regulations (SanPiN 2.1.575–96), construction of new factories of that type in urban residential territories is forbidden. A production facility for cut crystal articles should be surrounded by a sanitary-protective zone 500 m wide (SanPiN 2.2.1.5/2.1.1.567–96). Furthermore, the sufficiency of the sanitary-protective zone for such factories has to be justified by calculations of the expected levels of pollution of the ambient medium and the production facility proper.

Since lead compounds are widely used in the production of crystal glass, as well as in treatment and decorating of glass articles, we investigated the process of volatilization of lead compounds, their emission into the working space, and their effect on the health of personnel.

Based on the results of this study, measures intended to reduce the lead compound contamination of the working-space air and the environment were developed [1].

In order to substantiate the importance of the measures intended to decrease lead contamination, it should be noted that lead belongs to grade 1 of dangerous chemicals (extremely toxic); lead can be accumulated in human organs and tissues and in plants as well. The sources of lead accumulating in the ambient environment are industrial enterprises and automobiles using ethylated gasoline.

The Ministry of Health of the Russian Federation adopted rigid maximum permissible concentration levels for the air in working premises. In addition to measuring the lead content in the working-zone area, it is required that biological media of personnel be analyzed (blood test for lead content). According to data of the World Health Organization, the average lead content in healthy individuals is 17 μg per 100 g of blood (without any symptoms of health problems). The lead content in the blood of workers who have contact with lead compounds reaches 80 μg per 100 g of blood.

The batch for melting crystal glass contains lead oxides in the form of red lead Pb_3O_4, lead monoxide PbO, and various lead-bearing materials: lead silicate, lead nitrate, etc.

The environment is polluted by lead compounds in all stages of lead glass production.

In the first stage, i.e., during batch preparation, the emission of lead-containing dusty materials into the working space and into the atmosphere depends on the degree of shielding and sealing of the equipment and the method for material transportation (for example, vacuum feeding of red lead), as well as on the availability of efficient dust-gas-purifying equipment.

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TABLE 1

Furnace (company)	Furnace description	Output, tons/day	Waste-gas volume, nm^3/sec	Toxic material	Quantitative parameters of atmospheric emission		
					g/m^3	g/sec	tons/year
Tank furnace No. 11 (Gusevskii Crystal Glass Works)	Electric* with gas-heated working zone	7.0	0.5***	Dust	0.085	0.48	15.28
				Lead compounds	0.024	0.134	4.310
Tank furnace No. 16 (Gusevskii Crystal Glass Works)	Gas-flame*	8.0	5.2	Dust and lead-compound emissions from two glass-melting furnaces			
Potter furnace (Gusevskii Crystal Glass Works)	The same	1.6	2.4	Dust	0.038	0.090	2.870
				Lead compounds	0.002	0.004	0.120
Tank furnace No. 7 (Zolotkovo JSC)	Electric* with gas-heated working zone	7.0	0.51***	Dust	0.007	0.040	1.26 0
				Lead compounds	0.004	0.002	0.072
Electric furnace (Experimental Glass Factory)	Slag-lining** with gas-heated working zone	0.15	0.49***	Dust	0.012	0.006	0.200
				Lead compounds	0.009	0.004	0.130

* PbO content in glass 16%.

** PbO content in glass 64.5%.

*** Waste gases from the working zone.

The most efficient devices for recovery of finely disperse lead-containing aerosol are tissue filters, as well as small-size electric filters currently produced by Élstat and Plim Companies (Russia) and other manufacturers.

A more complicated problem is the reduction of lead compound emissions during crystal glass melting. In this case the amount of pollutant emissions and ejections depends on the amount of lead compounds in the batch, the furnace efficiency, the waste-gas volume, the smoke-flue length, and the type of furnace.

Table 1 shows results of studying levels of atmospheric emissions from furnaces with different productivity. During charging and melting of the batch, lead-bearing dust penetrates into the shop air medium through intake windows, peepholes, and hoppers. Usually the lead compound concentration at the working places exceeds the maximum permissible concentration. This is approved by the results of glass works inspection.

A comparison of the amount of lead compound atmospheric emissions from gas-flame and electric glass-melting furnaces shows that electric furnaces in which melting proceeds underneath the batch layer are the most environment-friendly (Table 2). However, gas heating in the working zone decreases the electric-melting efficiency.

In spite of a significant decrease in the amount of lead compound emission in the case of electric melting, after the pollutant is dissipated in the atmosphere the maximum permissible concentration for air near the ground ($0.001\ mg/m^3$) is not attained, because electric furnaces have lower chimneys than gas-flame furnaces.

TABLE 2

Parameter	Gas-flame regenerative furnace	Deep tank electric furnace
Waste-gas volume, nm^3/sec	3.27	1.90
Emission concentration, g/m^3	0.095	0.020
Emission rate, g/sec	0.31	0.04
Overall emission, tons/year	9.7	1.3

Therefore, when crystal glass is melted in electric furnaces, it is necessary to take technological measures to reduce emissions, primarily, to use granulated and compacted raw materials. Data on the environmental advantage of this method were published in [1 – 3].

Another measure intended to reduce atmospheric emissions should be recovery of lead compounds employing purification devices.

The most effective device for small-sized glass-melting furnaces is the cassette pulse filter developed by the Research and Development Institute of Glass together with the Semibratovskii branch of NIIOgaz Institute. The efficiency of this filter reaches 98%. This filter is used at the Neman glass factory and the Gusevskii crystal glass works. The capacity of the device is $5000 – 10,000\ m^3/h$. The dust recovered by this filter contains lead compounds and alkali batch components. These wastes at the Neman factory are used for preparation of pigments and colorants.

The working-space air at the site intended for grinding and decoration of glass articles employing lead-containing silicate colorants is contaminated with lead-bearing dust. The problem of the effect of dust containing lead combined with silicates on human health has frequently been discussed in the domestic literature.

Research data indicate that lead existing in a bound state (aerosol in glass grinding, frit aerosol, aerosol emitted in glass decoration) also has a negative effect on personnel, and certain symptoms of lead intoxication (reticulocytosis, etc.) were identified in examination of workers occupied in the indicated production divisions [4]. Therefore, the processes of glass treatment, decoration, and application of lead-containing frit should be based on advanced technologies, up-to-date equipment, and sanitary-engineering devices.

Thus, the most urgent problem in the production of household glass and cut crystal is the need to reduce atmospheric emissions of chemicals classified as grade 1 danger, primarily lead compounds.

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